RELATIONSHIP BETWEEN CLOUD FRACTION AND CLOUD ALBEDO: COMBINED OBSERVATIONAL-MODELING-THEORETICAL INVESTIGATION

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ABSTRACT

Cloud fraction and cloud albedo have long occupied the central stage as key cloud quantities in studying cloud-climate interaction; however their quantitative relationship has been much less studied and understood, in both observations and climate models. This work explores this crucial relationship using a combined approach of empirical analysis of observational data, comparative examination of climate model results, and theoretical development of parameterizations. Three years (1999-2001) of hourly averaged ARM surface-based observations and GOES satellite retrievals at the SGP site are analyzed, and compared with the corresponding three years of SCM simulations driven by the continuous ARM large-scale forcing. The preliminary results (Fig 1) show that 1) cloud albedo is positively related to cloud fraction, and 2) although all the models catch the general feature of positive correlation, they differ significantly in details, with inter-model difference markedly larger than that between the two measurements. This finding poses a new challenge to parameterization development – self-consistency of parameterizations for cloud fraction and cloud albedo and the role of cloud-overlap assumptions. Further theoretical effort will seek to understand the physics underlying the albedo-fraction relationship and take up this challenge.
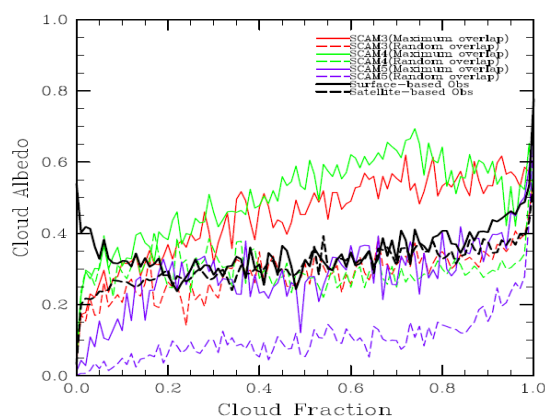

Figure 1 Relationship between cloud albedo and cloud fraction based on three year (1999-2001) hourly data. The surface-based and satellite observations are derived from ARM-ground-based and GOES radiation measurements, respectively. SCAM3, 4, 5 correspond to the three versions of the NCAR CAM.